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(54) Heat sealed, ovenable food carton.

(57) Lids, closures and/or cartons for distributing, marketing and heating small portions of prepared food are fabricated with a paperboard Structural substrate coated with a heat activated (or sealable) coating of water soluble acrylic emulsion that is applied by means of a press in conjunction with a printing operation or, alternatively, by a coating operation separate from the printing operation. Other critical coating characteristics are that it is heat sealable to itself, to polymers such as polyethylene terephthalate and directly to unprimed paperboard, with or without a clay coating. Additionally, the coating may be tack bonded at 250 °F or greater and is mass stable below 400 °F.

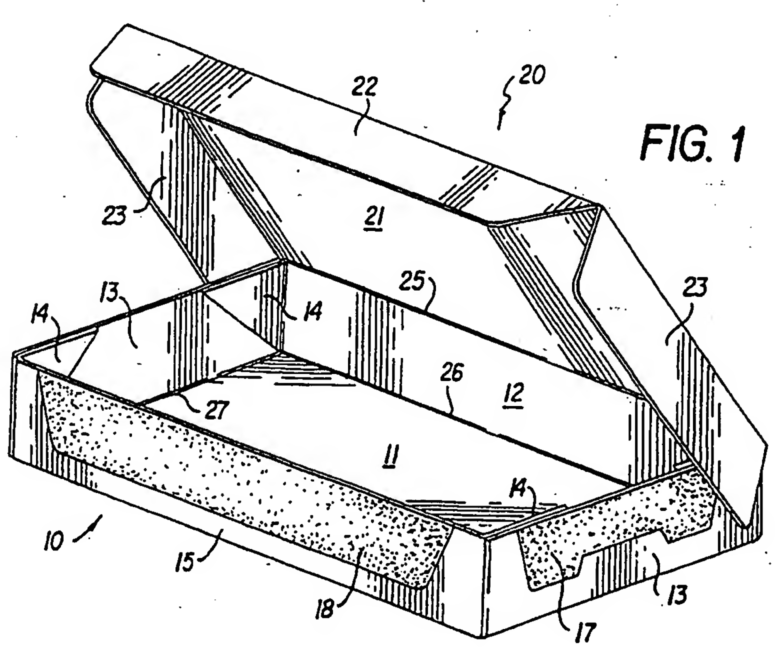

FIG. 1

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The present invention relates to paperboard packages or cartons suitable for distributing, marketing and heating Prepared food products.

To meet complex purity and performance specifications, highly specialized packaging systems have been developed for distributing, marketing and heating food for service. Many of such packaging systems are based upon a structural substrate folded from Preprinted and die-cut bleached sulphate paperboard as described by U. S. Patent No. 4,249,978 to T. R. Baker, U. S. Patent No. 3,788,876 to D. R. Baker et al and U. S. Patent No. 4,930,639 to W. R. Rigby.

To protect the paper package or carton from moisture degradation due to direct contact with a food substance, the internal surfaces of such a carton are coated with a moisture barrier of one or more continuous films of thermoplastic resin. These films are usually applied to the paperboard web, prior to printing and cutting, as a hot, viscous, extruded curtain. Polyethylene (LDPE), polypropylene (PP) and polyethylene terephthalate (PET) are three of the more prevalent thermoplastic resins used for this purpose.

Covers for paperboard based food cartons may take one of several forms including a top flap that is an integral continuation of the same paperboard sheet or "blank" from which the carton vessel is erected, such top flap being crease hinged to one sidewall of the carton. Another type of cover has been an independent paperboard sheet that is adhesively secured or plastic fuse bonded to a small perimeter flange folded from the upper edge of the carton vessel sidewalls.

Cartons and carton covers of the foregoing description require two separate converting operations to produce the carton blank following manufacture of the paperboard: 1) extrusion of the thermoplastic barrier coating and, 2) printing of the sales graphics. Consolidating both of these operations to a single operation offers obvious economic advantages. Moreover, minimum coat weights for an extruded moisture barrier typically range from 11 to 26 pounds per 3000 ft.^{2} ream. Lighter coat weights usually result in an inconsistent polymer layer or a layer with little or no adhesive property.

Finally, extruded polymer moisture barriers greatly complicate those recycling procedures necessary to recover the carton fiber constituency.

It is therefore, an object of the present invention to provide a food packaging carton which utilizes a specialized polymer (water based/acrylic emulsion) to serve the same functions as an extruded polymer but is or may be applied in the same converting operation or process used to print the sales graphics.

Another object of the present invention is to specify the critical characteristics of a water based polymer emulsion that may be printing press applied to a food contacting paperboard surface.

Another object of the present invention is to provide a printing press applied polymer coating on Paperboard cartons for direct food contact applications that quickly heat seals to itself, to PET, or to an unprimed, clay coated surface.

These and other objects of the invention to be subsequently described or made apparent are accomplished by a specialized polymer coat of water-based acrylic emulsion applied by printing or flexographic press to a paperboard carton or closure element at a rate of one to nine pounds of solids per 3000 ft.^{2} of surface area. The emulsion must contain no more than 5% of the total polymer units derived from acrylic acid and neither melt nor lose significant mass at temperatures below 400 °F. Applied in the liquid state, a minimum coat weight of the specialized polymer necessary to achieve essential properties is less than an extruded coating.

Relative to the drawing wherein like reference characters designate like or similar elements:

FIGURE 1 is a pictorial view of a paperboard food carton having an integral closure lid;

FIGURE 2 is a plan view of a one-piece paperboard blank from which the Figure 1 carton is erected;

FIGURE 3 is a pictorial view of a two-piece paperboard food carton having a separate closure lid; and,

FIGURE 4 is a pictorial view of a one-piece paperboard blank from which the Figure 3 vessel portion is erected.

Paperboard substrate for the present invention is typically a 0.018 inch thick bleached sulphate sheet. Definitively, the term paperboard describes paper within the thickness range of .008 to .028 inches. The invention is relevant to the full scope of such range as applied to packaging and beyond.

When used for food carton stock, paperboard is usually clay coated on at least one side surface and frequently on both sides. The trade characterizes a paperboard web or sheet that has been clay coated on one side as C1S and C2S for a sheet coated on both sides. Compositionally, paperboard coating is a fluidized blend of minerals such as coating clay, calcium carbonate, and/or titanium dioxide with starch or adhesive and smoothly screeded onto the traveling web surface. Successive densification and polishing by calendering finishes the mineral coated surface to a high degree of smoothness and a superior graphics print surface.

When C1S paperboard is used for food packaging, the clay coated surface is prepared as the outside surface. Pursuant to the present invention, the other side is coated with a specialized, water based acrylic

emulsion to be further described in grater detail. The coating process may be by means of a gravure roll, a rod coater, air knife or screed blade.

A typical application rate for an independent, C1S paperboard lid that is to be heat sealed to a food carton vessel rim flange is in the range of 3 to 9 pounds per 3000 $ft.^2$ ream. A C2S food carton lid would require only 1 to 4 pounds per 3000 $ft.^2$ ream due to the great "hold out" moisture barrier properties inherent in a calendered, clay coated paper surface. Apparently due to scoring and folding designs and material stresses, shallow food tray cartons require the higher coat weights of 6 to 9 pounds per 3000 $ft.^2$ ream.

One embodiment of the present invention anticipates a carton construction similar to that of Figures 1 and 2 which broadly comprises a vessel 10 and a closure 20. The vessel components include the bottom panel 11, back wall 12, end walls 13, front wall 15 and corner gussets 14. The closure components include the top panel 21, front flap 22 and side flaps 23. Score line 25 between the top panel 21 and back wall 12 functions as an integral hinge for closure 20.

Figure 2 illustrates the flat blank for the Figure 1 carton as cut from a paperboard web of great length. From a reel material handling system, the uncoated side of a C1S paperboard the web is continuously coated by means of a gravure applicator with a 6 to 9 pounds per ream coat weight of water based acrylic emulsion. As illustrated by Figure 1, this would be the inside surface of the vessel 10. Related to Figure 2, the emulsion coated side of the web would be opposite from the face shown. Also from a reel material handling system, either simultaneous with the emulsion coat application or separately the clay coated outside surface of the web is printed with sales and informational graphics. The outside, clay coated surface is also printed in the shaded areas of 16, 17 and 18 respective to the gussets 14, the end walls 13 and the front wall 15 with a 1 to 4 pound per ream (3000 $ft.^2$) coat weight of the water soluble acrylic emulsion.

In the normal course of events, scored and printed carton blanks as depicted by Figure 2, cut from the web continuity, are delivered to a food processor as stacks of independent articles in an open or flat configuration. Either on or off the product filling line, the vessel 10 is erected by folding walls 12, 13 and 15 about respective score lines 26, 27 and 28 to a position 90° of the bottom panel 11. Similarly, top flaps 22 and 23 are folded 90° to the top panel 21 about respective score lines 24 and 29. The folds described are merely break-overs; meaning that due to the high degree of paperboard stiffness and memory, the 90° fold position will not be retained without additional means of positional security. Gussets 14 provide such security to the vessel walls.

As the printed emulsion applied to the shaded gusset areas 16 is heated to the tack temperature, the gusset panels are folded about gusset scores 19 and the integral vessel walls 12, 13 and 15 are turned to the erect position. These dynamics bring the gusset half portions on opposite sides of a respective gusset score 19 into face-to-face opposition and contact. At tack temperature, the emulsion fuses. Subsequent chilling secures the folded gusset position and hence, the erect positions of the vessel walls.

Although secured, the folded gusset 14 projects a triangular fin into the carton vessel space. This disadvantage is dispatched as shown by Figure 1 by heating one side of each triangular gusset fin and a portion of an adjacent inside wall. In this configuration, it will be recalled that the entire inside surface of the carton blank was curtain coated with the present water based acrylic emulsion. This inside emulsion coating covers both triangular sides of the gusset and respective carton walls. Selective heating and pressure will secure the gusset fin to the inside plane of a respective side wall 13.

To be further noted from the geometry of gusset 14, no cut edge is presented to the internal vessel volume formed within the carton walls. All surfaces within that vessel volume have been coated by the water based acrylic emulsion moisture barrier.

Obvious alternative permutations of the Figure 1 and 2 carton embodiments would, in one case, include a hot extruded polymer coating on the inside surface of the carton in lieu of the water based acrylic emulsion coating. Shaded areas 17 and 18 printed on the outside surfaces of end walls 13 and front wall 15, respectively, with the water based acrylic emulsion will also heat seal to a hot extruded polymer on the inside surfaces of the closure flaps 22 and 23.

Another permutation of the Figure 1 carton would be a C2S blank having a 1 to 4 pounds per ream coat weight of water based acrylic emulsion applied to the inside surface.

In a second embodiment of the invention, illustrated by Figures 3 and 4, the vessel 40 opening is sealed by an independent cover 50.

A coated and graphically printed web is cut into blanks as illustrated by Figure 4 to include a bottom panel 41, end panels 42 and side panels 43. Score lines 46 and 47 hinge the end and side walls to the bottom panel. Similarly, score lines 48 and 49 hinge the end and side walls to outwardly turned flange areas 44 and 45.

In a variant form of the vessel 40, a C1S source web top side is not extrusion coated prior to blank cutting. The graphically printed and erected blank is positioned within a blow mold cavity as taught by U. S. Patent No. 5,169,470 to have the interior surfaces coated with a gas expanded parison of hot extruded polymer such as PET. By this procedure the moisture barrier flows continuously over the vessel 40 interior surface area and out onto the top surfaces of the flanges 44 and 45.

The closure 50 for the vessel 40 opening is, most simply, a flat sheet of C1S or C2S paperboard cut to the projected plan form of the erected flange perimeter. Pursuant to the invention, this closure 50 would include a continuous, coating of water based acrylic emulsion over the underside surface for a mating bond to the vessel flanges 44 and 45. The closure 50 is heat sealed to the vessel 40 flanges by heating and pressing the mating surfaces together. The printed acrylic emulsion side of the closure 50 is heated in the same manner as an extrusion coated surface.

One representative source of the water-based acrylic emulsion coating relied upon by the present invention includes the MW 10 product of Michelman, Inc., 9080 Shell Road, Cincinnati, Ohio. Another such source is the CARBOSET XPD-1103 product of B.F. Goodrich Company, 9911 Brecksville Road, Brecksville, Ohio.

The Michelman MW 10 product comprises a styrenated acrylic resin and high density polyethylene wax. The Goodrich CARBOSET XPD-1103 product is described as an anionic emulsion of acrylic ester copolymer in water. CARBOSET XPD-1103 is also characterized as a styrene-acrylic copolymer emulsion containing heat activated curing mechanisms stimulated by a 250-300 °F curing temperature.

Essential properties common to both of these water-based acrylic emulsions are that no more than 5% of the total polymer units are derived from acrylic acid. Below 400 °F, neither of the described materials will melt, degrade or lose mass (solvent outgassing). Most acrylic emulsion coatings can not be considered for the present food contacting utility due to the acid functionality group of the polymer.

Other properties of the present water-base acrylic emulsion are that it is heat sealable to itself, to clay coated board and to other polymer coatings such as polyester and polypropylene. The printed and cured coating is thermally stable between -40 °F and 250 °F.

Representative heat sealibility performance of the Michaelman MW 10 product is described by Table 1. Samples used for the Table 1 test series included a press applied coating printed upon a sulphate paperboard that was clay coated on both sides. The cooperative PET samples to which the present water-based acrylic emulsion is fused, carried a 21 lbs/3000 ft.^{2} ream hot extrusion coating of PET. Cooperative experimental conditions included a constant 60 psi clamping pressure at 350 °F temperature. The dwell time under clamp was varied from 0.25 seconds to 2.0 seconds. "HSC" refers to the Michaelman MW 10 heat seal coating product applied to the 0.018 in. caliper, clay coated paperboard test sample at the rate of 3 lbs/3000 ft.^{2} ream.

TABLE 1

Dwell Time (sec)	.25	.40	.50	.75	1.00	1.25	1.50	1.75	2.00
PET/PET	---	---	---	0%	10%	50%	100%	100%	100%
PET/HSC	0%	10%	100%	100%	---	---	---	---	---
HSC/HSC	0%	85%	100%	100%	---	---	---	---	---
PET/Clay	0%	---	0%	0%	0%	100%	100%	---	---
HSC/Clay	0%	---	0%	0%	100%	100%	100%	---	---

Those of ordinary skill in the art will recognize the utility value of the present invention for packaging food to be heated, in the original distribution carton, within a traditional convection oven. Alternatively, the food may also be heated in a microwave oven, if desired.

Although the preferred embodiments of the present invention emphasize the unique functional and economic advantages associated with a specialized heat sealable/ovenable coating it should be recognized that the press applied water-based acrylic emulsion of the present invention is also functional as a moderately effective area moisture barrier.

Claims

1. A paperboard sheet for covering a food distribution vessel fill opening, said sheet having a first side including a calendered coasting of particulate minerals, and a second side supporting a continuous coating of a water based acrylic emulsion which is used for heat sealing and as a vapor barrier for said

sheet to a filled food distribution vessel in a covering position over a corresponding vessel fill opening.

2. The paperboard sheet as described by claim 1 wherein said water based acrylic emulsion is mass stable below 400 °F and is tack bonded at about 250 °F or greater.

3. The paperboard sheet as described by claim 1 wherein said water based acrylic emulsion comprises a styrene-acrylic copolymer wherein no more than 5% of the total copolymer units are derived from acrylic acid.

4. The paperboard sheet as described by claim 1 wherein said water based acrylic emulsion is applied to said second side with a coat weight of 6 to 9 pounds per 3000 $ft.^2$.

5. The paperboard sheet as described by claim 1 wherein said second side is also coated with a calendered coat of particulate minerals which has a 1 to 4 pounds per 3000 $ft.^2$ coating of said water based acrylic emulsion applied thereover.

6. A paperboard carton for food products having vessel means with a content fill opening and a closure means for covering said fill opening, a first surface area on said vessel means around said fill opening for contiguously facing a second surface area on said closure means when positioned over said fill opening; and, a water-based acrylic emulsion coating on at least one of said surface areas for heat sealing said first and second surface areas together.

7. A paperboard carton as described by claim 6 wherein said water based acrylic emulsion is mass stable below 400 °F and is tack bonded at about 250 °F or greater.

8. A paperboard carton as described by claim 6 wherein said water based acrylic emulsion comprised a Styrene-acrylic copolymer wherein no more than 5% of the total polymer units are derived from acrylic acid.

9. A paperboard carton as described by claim 6 wherein said closure means is formed from a paperboard sheet having a calendered coating of particulate minerals on one side thereof and a 6 to 9 pounds per 3000 $ft.^2$ coating of said water based acrylic emulsion on the other side thereof.

10. A paperboard carton as described by claim 6 wherein said closure means is formed from a paperboard sheet having a calendered coating of particulate minerals on both sides thereof and a 1 to 4 pounds per 3000 $ft.^2$ coating of said water based acrylic emulsion over one of said mineral coatings.

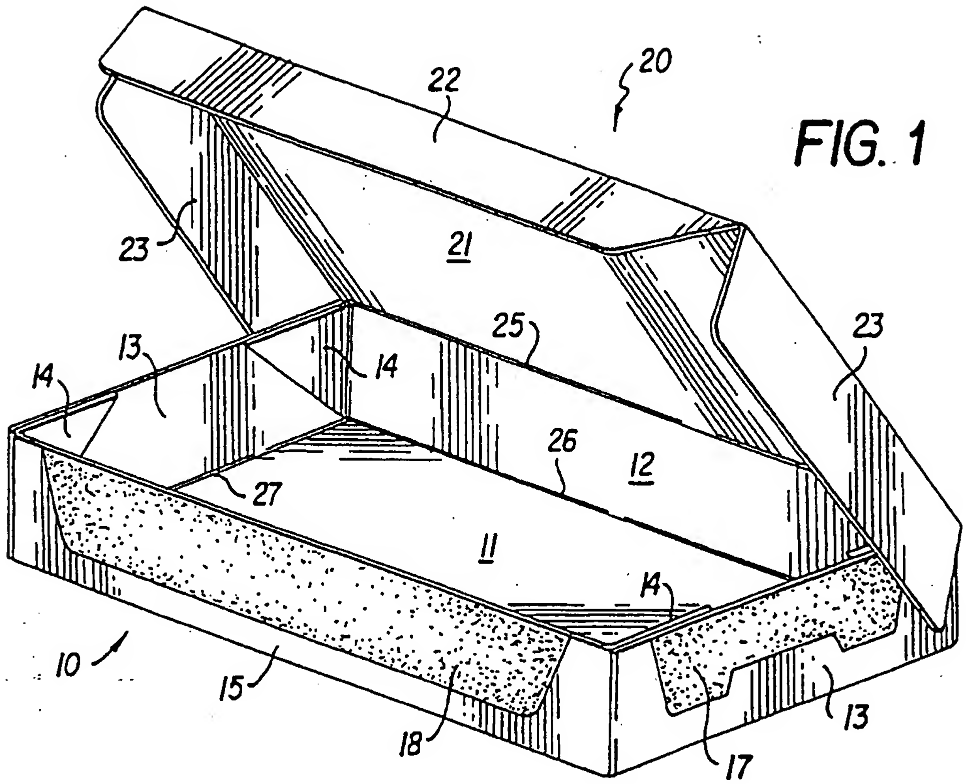
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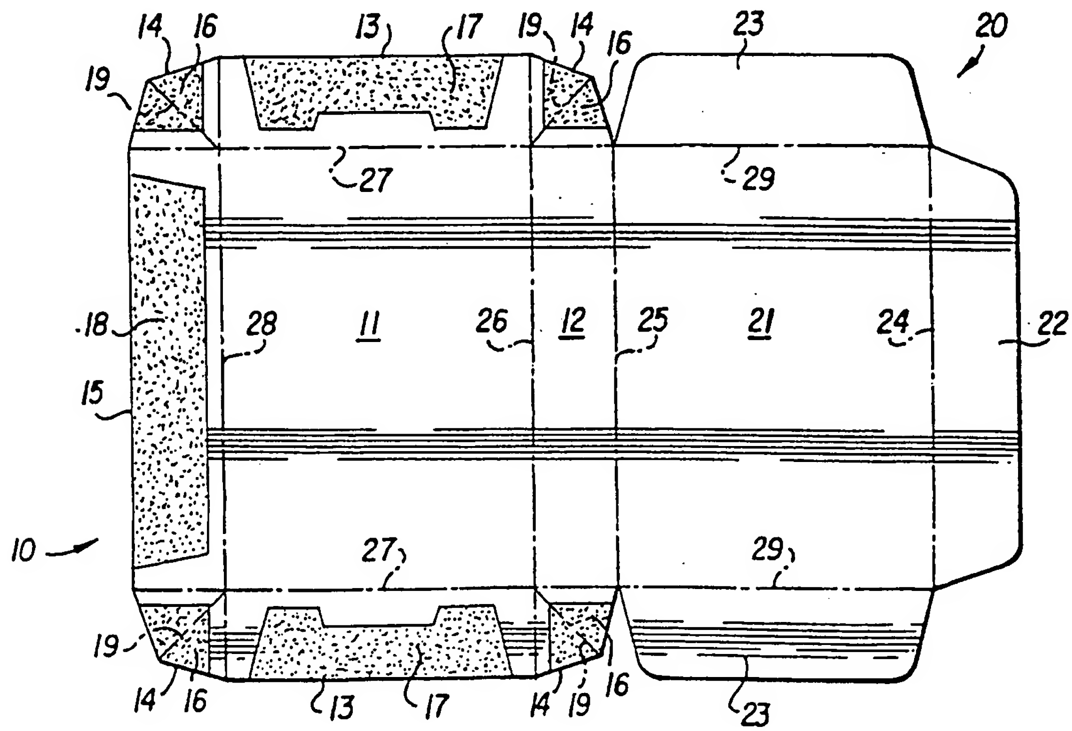
FIG. 1

FIG. 2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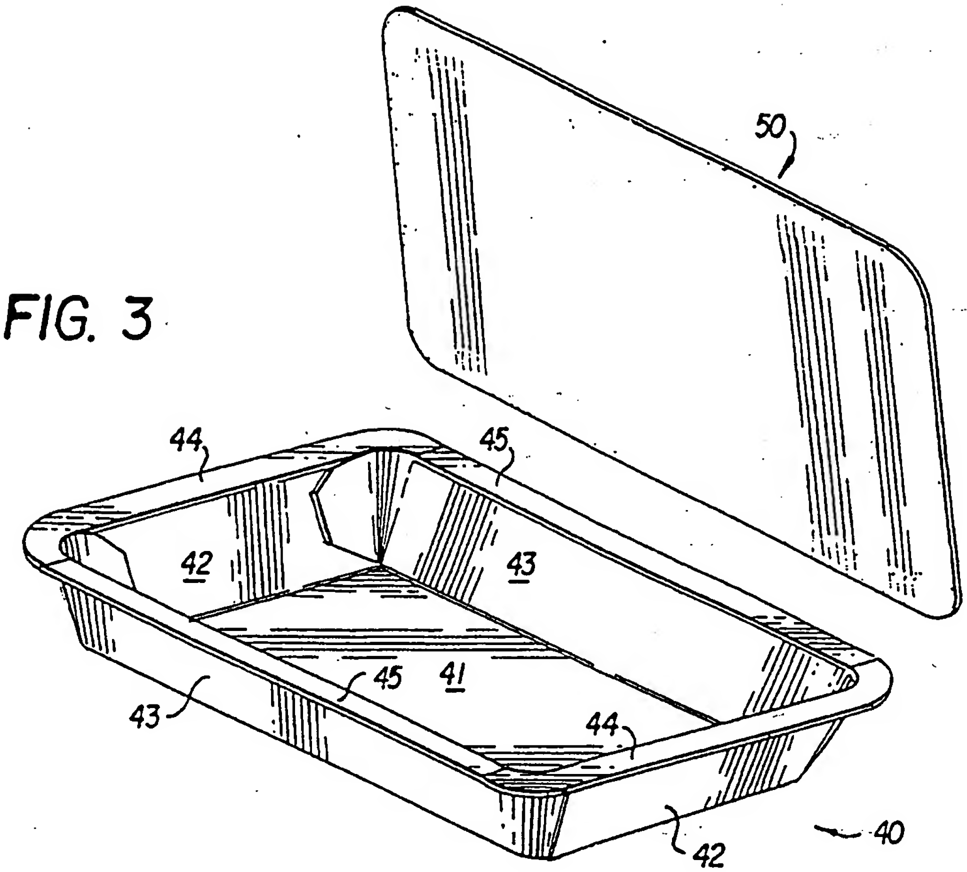
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FIG. 3

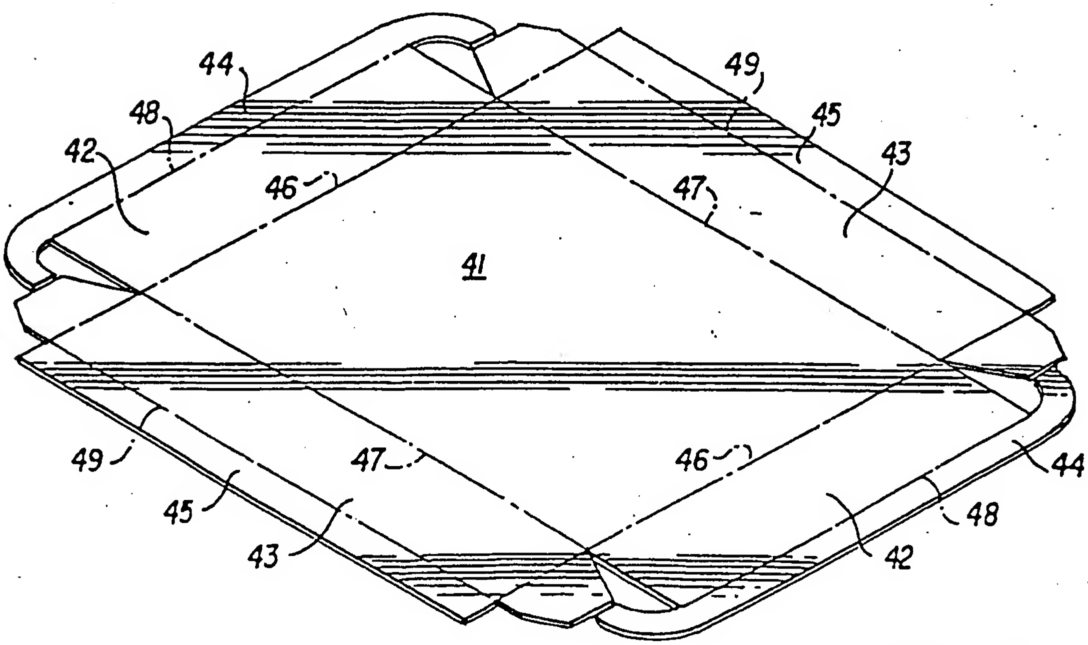
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FIG. 4